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Cancer Mortality Among Jewelry Workers

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Mortality was investigated for the years 1950–1980 for 1,009 male members of a New York jewelry workers union, and for the years 1984–1989 among 919 men and 605 women identified as jewelry workers on death certificates from 24 states. Malignant neoplasms were excessive for male union members (proportional mortality ratio [PMR] = 1.17; 95% confidence interval [CI]: 1.02–1.33) and female jeweler deaths from the 24 states (PMR = 1.24; 95% CI: 1.07–1.42). Deaths due to nonmalignant causes were not unusual, except for excesses, in union males, of the circulatory system (PMR = 1.10; 95% CI: 1.02–1.19), including arteriosclerotic heart disease (PMR = 1.25; 95% CI: 1.14–1.37) and rheumatic heart disease (PMR = 3.02; 95% CI: 1.94–4.50). Cancers of the digestive tract were proportionally elevated among union males (proportional cancer mortality rate [PMR] = 1.13; 95% CI: 0.89–1.41) and among deaths from the 24 states (PCMR = 1.22; 95% CI: 1.01–1.47). For the 24 states, excesses for digestive cancer were found for both males (PCMR = 1.19; 95% CI: 0.90–1.54) and females (PCMR = 1.26; 95% CI: 0.96–1.62). Regarding specific sites in the digestive tract, colon cancer excesses were found in union males (PCMR = 1.53: 95% CI: 1.05–2.15), and for men (PCMR = 1.27; 95% CI: 0.82–1.88) and women (PCMR = 1.36; 95% CI: 0.92–3.27) in 24 states. Also, in the 24 states, excesses were noted for esophageal cancer (PMR = 2.03; 95% CI: 1.08–3.47) and stomach cancer (PCMR = 1.66; 95% CI: 0.95–2.69), due to excess stomach cancer in women (PCMR = 2.50; 95% CI: 1.20–4.61). Marginal proportional excesses were found for malignancies of the hematolymphopoietic system in union males (PCMR = 1.12; 95% CI: 0.72–1.67) and among deaths from 24 states (PCMR = 1.23; 95% CI: 0.90–1.66), particularly due to non-Hodgkin's lymphoma deaths (PCMR = 1.39; 95% CI: 0.93–2.00). The wide variety of exposures in this industry, particularly to metals and solvents, could possibly involve excess risk for malignancy at these sites.

Key words: malignant neoplasms, jeweler deaths, proportional mortality

INTRODUCTION

Jewelry manufacture workers are exposed to a number of potentially hazardous substances, including metals such as silver, gold, beryllium, zinc, antimony, aluminum, lead, arsenic, cadmium, mercury, and copper; lubricating oils; degreasers such

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as tri- and perchloroethylene; solvents such as toluene and xylene; acids such as hydrochloric, sulfuric, orthophosphoric, hydrofluoric, and nitric; dusts such as talc, possibly containing asbestos, and silica; aluminum oxide and other abrasives; soldering fumes; cyanide; chrome- and nickel-plating baths; spot welding fumes; and epoxy glues and resins [Quinn et al., undated; Martin, 1978]. Skin hazards [Samitz and Mori, 1948], as well as cadmium [Baker et al., 1979] and mercury [Copplestone and McArthur, 1967] hazards have been described, but few epidemiologic studies have been carried out among jewelry workers.

Sparks and Wegman [1980] described the proportional mortality of 931 men (135 cancer deaths) who died between 1956–1975 in Attleboro, MA, and who had the occupation of jewelry worker noted on the death certificate. An excess proportion of pancreas cancer was found in the entire group; among polishers, excesses of stomach cancer and stomach ulcer occurred. Dubrow and Gute [1987] evaluated cause-specific mortality patterns among 3,141 Rhode Island jewelry workers identified from death certificates, 1968–1978 (629 cancer deaths). Among males, elevated risks were noted for nonmalignant kidney disease, liver cancer, drug dependence, and accidental poisonings. Among females, elevated risks were noted for stomach cancer, peptic ulcer, diseases of the skin and subcutaneous tissue, and drug dependence.

To obtain additional information on the cancer experience of jewelry workers, we conducted two proportional mortality studies: a study among male members of a New York jewelry workers union, and an analysis of causes of deaths among male and female jewelry workers identified from death certificate registrations in 24 states.

MATERIALS AND METHODS

In the first study, members, between 1950–1959, of the Amalgamated Jewelry, Diamond and Watchcase Workers Union, Local 1, New York City, who were active for at least 2 years, were eligible for study. From union records of Local 1, name, social security number, birth date, initiation date, job title (trade), and a complete history of union dues payments were abstracted. In total, 5,645 subjects were identified for study, including, by race, 4,305 whites, 553 nonwhites, and 787 subjects of unknown race; by sex, 4,515 males, 1,083 females, and 47 subjects of unknown sex. Follow-up for mortality was carried out to January 1, 1980, through union records, the Social Security Administration, Veterans Administration, motor vehicle, and credit bureau records. For those deceased, death certificates were requested and coded according to the ICD 8th Revision [National Center for Health Statistics (NCHS), 1967]. Observed proportions of deaths by cause were compared with expected proportions of deaths by 5-year age-specific and calendar-year-specific periods among appropriate race and sex groups from the U.S. general population.

The second study was based upon death certificates, 1984–1989, for deaths among blacks and whites in 24 U.S. states (New Hampshire, Maine, New Jersey, Ohio, Rhode Island, Vermont, Wisconsin, West Virginia, Tennessee, North Carolina, Nebraska, Missouri, Kentucky, Kansas, Indiana, Idaho, Colorado, Georgia, Nevada, New Mexico, Oklahoma, South Carolina, Utah, and Washington). Since 1984, the National Cancer Institute (NCI), the National Institute for Occupational Safety and Health (NIOSH), and the NCHS have been supporting the coding of

TABLE II. Proportional Mortality (PMR) in Male Jewelry Workers in a New York Union and in Male and Female Jewelry Workers in 24 States*

	Union males			24 states males			24 states females			24 states total	
Cause of Death	Obs	O/E	95% CI	Obs	O/E	95% CI	Obs	O/E	95% CI	O/E	95% CI
Malignant neoplasms	226	1.17	1.02–1.33	203	0.96	0.83–1.10	204	1.24	1.07–1.42	1.08	0.98–1.19
Infective and parasitic	4	0.38	0.10–0.97	18	1.30	0.77–2.05	11	1.28	0.64–2.29	1.29	0.87–1.86
Allergic, endocrine, metabolic	20	1.15	0.70–1.77	18	0.92	0.54–1.45	15	0.73	0.41–1.21	0.82	0.57–1.16
Diabetes	16	1.08	0.62–1.76	12	0.85	0.44–1.48	10	0.63	0.30–1.16	0.73	0.46–1.11
Mental disorders	0	0.00	0.00–0.82	5	0.55	0.18–1.29	5	0.93	0.30–2.16	0.69	0.33–1.27
Central nervous system	9	1.21	0.55–2.29	19	1.27	0.76–1.98	8	0.69	0.30–1.35	1.01	0.67–1.47
Circulatory system	616	1.10	1.02–1.19	426	1.00	0.91–1.10	236	0.88	0.77–1.00	0.95	0.88–1.03
Rheumatic heart	24	3.02	1.94–4.50	4	2.45	0.66–6.26	1	0.31	0.00–1.72	1.03	0.33–2.40
Arteriosclerotic heart	477	1.25	1.14–1.37	289	1.05	0.93–1.18	161	1.06	0.90–1.24	1.05	0.96–1.16
Vascular central nervous system	66	0.78	0.60–0.99	56	1.00	0.76–1.30	33	0.68	0.46–0.95	0.85	0.68–1.05
Respiratory	35	0.54	0.37–0.75	82	0.90	0.71–1.11	43	0.91	0.66–1.23	0.90	0.75–1.08
Pneumonia	18	0.73	0.43–1.15	31	0.90	0.61–1.27	15	0.86	0.48–1.41	0.88	0.65–1.18
Emphysema	5	0.30	0.10–0.70	11	1.25	0.62–2.23	2	0.48	0.05–1.75	1.00	0.53–1.72
Digestive	34	0.77	0.54–1.08	32	1.07	0.73–1.51	25	1.12	0.73–1.66	1.09	0.83–1.41
Gastric and duodenal ulcer	6	0.86	0.31–1.86	4	1.45	0.39–3.72	1	0.54	0.01–3.01	1.09	0.35–2.53
Cirrhosis	11	0.54	0.27–0.97	15	1.41	0.79–2.33	4	0.62	0.17–1.58	1.11	0.67–1.73
Genitourinary	12	0.80	0.41–1.39	21	1.32	0.82–2.01	15	1.39	0.78–2.30	1.35	0.94–1.87
Ill-defined conditions	4	0.37	0.10–0.94	9	1.07	0.49–2.03	3	0.55	0.11–1.61	0.87	0.45–1.51
External causes	30	0.42	0.28–0.60	75	1.09	0.85–1.36	29	0.93	0.63–1.3	1.04	0.85–1.26

*Obs = observed number of deaths; O/E = Obs/Expected number of deaths.

TABLE III. Proportional Cancer Mortality (PCMR) in Male Jewelry Workers in a New York Union and in Male and Female Jewelry Workers in 24 States*

	Union males			24 States males			24 States females			24 States total	
Cause of death	Obs	O/E	95% CI	Obs	O/E	95% CI	Obs	O/E	95% CI	O/E	95% CI
Buccal cavity and pharynx	4	0.59	0.16–1.50	2	0.51	0.06–1.84	2	0.81	0.09–2.93	0.63	0.17–1.60
Digestive and peritoneum	75	1.13	0.89–1.41	56	1.19	0.90–1.54	59	1.26	0.96–1.62	1.22	1.01–1.47
Esophagus	3	0.55	0.11–1.61	10	2.21	1.06–4.06	3	1.87	0.32–4.68	2.03	1.08–3.47
Stomach	12	0.92	0.47–1.60	6	1.06	0.39–2.30	10	2.50	1.20–4.61	1.66	0.95–2.69
Colon	33	1.53	1.05–2.15	25	1.27	0.82–1.88	30	1.36	0.92–3.27	1.32	0.99–1.72
Rectum	6	0.78	0.29–1.71	4	1.26	0.34–3.22	2	0.68	0.08–2.47	0.98	0.36–2.14
Liver	3	0.63	0.13–1.83	1	0.33	0.00–1.82	4	1.11	0.30–2.84	0.75	0.24–1.75
Pancreas	17	1.35	0.78–2.15	6	0.66	0.24–1.44	9	0.86	0.39–1.64	0.77	0.43–1.27
Respiratory system	69	0.96	0.75–1.22	66	0.90	0.70–1.15	44	0.99	0.72–1.33	0.94	0.77–1.13
Larynx	3	0.91	0.18–2.65	2	0.94	0.11–3.38	0	0.00	0.00–5.23	0.70	0.08–2.54
Lung	64	0.95	0.73–1.21	64	0.91	0.70–1.16	44	1.02	0.74–1.37	0.95	0.78–1.15
Breast	—			—			30	0.78	0.52–1.11	—	
Genital organs (female)	—			—			22	1.00	0.63–1.51	—	
Prostate	8	0.40	0.17–0.78	26	1.07	0.70–1.57	—			—	
Bladder	6	0.76	0.28–1.64	4	0.68	0.18–1.75	2	0.80	0.09–2.90	0.72	0.26–1.57
Kidney	6	1.13	0.41–2.47	3	0.63	0.13–1.85	2	0.54	0.06–1.95	0.59	0.19–1.38
Brain and central nervous system	3	0.57	0.11–1.65	3	0.72	0.14–2.10	5	1.04	0.33–2.42	0.89	0.38–1.76
Hemato lymphopoietic cancer	24	1.12	0.72–1.67	22	1.25	0.78–1.89	22	1.22	0.76–1.84	1.23	0.90–1.66
Non-Hodgkin's lymphoma	10	1.02	0.49–1.89	14	1.45	0.79–2.44	15	1.34	0.75–2.21	1.39	0.93–2.00
Hodgkin's disease	2	0.90	0.10–3.24	1	1.64	0.02–9.12	1	1.98	0.03–10.99	1.79	0.20–6.47
Multiple myeloma	4	1.36	0.37–3.48	3	0.94	0.19–2.76	6	1.65	0.60–3.60	1.32	0.60–2.51
Leukemia	11	1.21	0.60–2.17	7	0.95	0.38–1.96	6	0.94	0.34–2.04	0.95	0.50–1.62

*Obs = observed number of deaths; O/E = Obs/Expected number of deaths.

1.10; 95% CI: 1.02–1.19), arteriosclerotic heart disease (PMR = 1.25; 95% CI: 1.14–1.37), and rheumatic heart disease (PMR = 3.02; 95% CI: 1.94–4.50) in union males.

In Table III, the PCMR, are presented for the study groups. Cancers of the digestive tract were proportionally elevated among union males (PCMR = 1.13; 95% CI: 0.89–1.41) and for deaths from the 24 states (PCMR = 1.22; 95% CI: 1.01–1.47). For the 24 states, excesses for digestive cancer were found for both males (PCMR = 1.19; 95% CI: 0.90–1.54) and females (PCMR = 1.26; 95% CI: 0.96–1.62). Regarding specific sites in the digestive tract, colon cancer excesses were found in union males (PCMR = 1.53: 95% CI: 1.05–2.15), and for men (PCMR = 1.27; 95% CI: 0.82–1.88) and women (PCMR = 1.36; 95% CI: 0.92–3.27) in 24 states. Also, in the 24 states excesses were noted for esophageal cancer (PCMR = 2.03; 95% CI: 1.08–3.47) and stomach cancer (PCMR = 1.66; 95% CI: 0.95–2.69), due to excess stomach cancer in women (PCMR = 2.50; 95% CI: 1.20–4.61). For jewelry workers in Rhode Island, excesses were noted for esophageal (PCMR = 2.43; 95% CI: 1.05–4.79; number of cases = 8) and stomach cancer (PCMR = 1.44; 95% CI: 0.72–1.58; number of cases = 11), but not for colon cancer (PCMR = 1.02; 95% CI: 0.67–1.48; number of cases = 27). The excess for colon cancer in the 23 states, excluding Rhode Island, was PCMR = 1.65 (95% CI: 1.09–2.38, number of cases = 28).

Deaths due to other malignancies were not notable, except that marginal proportional excesses were found for malignancies of the hematolymphopoietic system in union males (PCMR = 1.12; 95% CI: 0.72–1.67) and among deaths from 24 states (PCMR = 1.23; 95% CI: 0.90–1.66), particularly due to non-Hodgkin's lymphoma deaths (PCMR = 1.39; 95% CI: 0.93–2.00). For Rhode Island, excesses were noted for deaths from malignancies of the hematolymphopoietic system (PCMR = 1.50; 95% CI: 1.00–2.17; number of cases = 28), particularly due to excesses of non-Hodgkin's lymphoma (PCMR = 1.71; 95% CI: 0.93–2.86; number of cases = 14).

For the male union members, it was possible to examine the findings with respect to year started in the union and duration of union membership. For cancer of the colon, no differences in risk were noted with respect to year of initial union membership (<1950: PCMR = 1.47, 1950–1959: PCMR = 1.64) or duration of union membership (<10 years: PCMR = 1.64, 10+ years: PCMR = 1.47). For the hematolymphopoietic malignancies, no substantial differences were found with respect to year of initial union membership (<1950: PCMR = 1.16, 1950–1959: PCMR = 1.06) or duration of union membership (<10 years: PCMR = 1.11, 10+ years: PCMR = 1.13).

We reviewed the "usual occupation" as reported on the death certificates of union members. For deceased union members, 58.6% were listed on the death certificate as jewelers. The percent reported as jewelers increased from 38.6% for those enrolled as union members for less than 5 years to 69.5% for those enrolled for 20+ years. Also for union members, a jewelry-related occupation was reported for 58.4% of cancer deaths and 58.6% of noncancer deaths. These data indicate that death certificate recording of occupation for jewelry workers is related to duration of employment (or, in this case, union membership), and that cancer deaths are not more likely to be so classified. The risk for cancer of the colon (PCMR = 1.60; 95% CI: 0.99–2.45) in union members classified as jewelers on the death certificate was similar to that shown for all union members (PCMR = 1.53).

DISCUSSION

This study suggests that workers in the jewelry industry may be at excess risk for malignancies of the digestive system. Excesses were noted for esophageal cancer in 24 states, due largely to an excess among Rhode Island jewelry workers. Stomach cancer mortality was strikingly in excess for women in the jewelry industry in 24 states. Colon cancer excesses were identified for jewelry workers in New York and in the 24 states. Further analysis of colon cancer indicated that the excesses identified in the 24 states were due to increased proportional mortality in 23 states, excluding Rhode Island.

The proportional mortality studies presented here can serve to generate hypotheses about excess cancer risk in the jewelry industry. The study of members of a New York jewelry union was designed as a retrospective cohort mortality study. Because of incomplete follow-up and death certificate ascertainment, it was, however, impossible to accurately determine mortality rates. As an alternative, proportional mortality analyses are presented. If the deaths ascertained for union members were a biased sample of all deaths, with respect to cause of death, then the estimates of disease risk would also be biased. We do not have independent information to address this. For the 24 states investigation, bias could also have occurred if cancer deaths are more (or less) likely to be classified as jewelers. We assessed this possibility, using the death certificate data from the New York union investigation, and found no direct association between cancer death and notification of occupation, on the death certificate, as jeweler. A related concern in proportional mortality analyses is the possibility of biased estimates of excess cancer risk, because deaths due to noncancer causes are often relatively low in occupational populations [Monson, 1990]. The PCMR was used in this study because overall cancer rates are likely less influenced by employment status than is overall mortality [Wong et al., 1985].

Previous studies of the jewelry industry [Sparks and Wegman, 1980; Dubrow and Gute, 1987] also found excesses for deaths due to digestive tract cancers, but of the pancreas, liver, and stomach. Studies of related industries have suggested increased risk for esophagus, stomach, and colon cancers. Excess risk for esophageal cancer has been noted in polishers and platers [Blair, 1980], in synthetic abrasive manufacturers [Wegman and Eisen, 1981], and for the lower third of the esophagus in workers exposed to metal dusts [Yu et al., 1988]. Excesses for stomach cancer have been suggested among synthetic abrasive manufacturers [Wegman and Eisen, 1981], workers exposed to metal grinding and cutting oils [Decouflé, 1978; Jarvholm et al., 1981], metal polishers [Jarvholm et al., 1982; Mant and Maynon-White, 1987], and for pyloric and antrum cancer among workers exposed to metal dust [Wu-Williams et al., 1990]. Excesses for colon cancer have been identified for lens and metal spectacle frame manufacturers [Wang et al., 1983]; among males with potentially high exposure to solvents and abrasives, and females with exposure to solvents and grinding wheel dust [Spiegelman and Wegman, 1985]; among workers grinding stainless steel [Svensson et al., 1989]; and among producers of art glass [Wingren and Englander, 1990]. Also, bearing plant workers exposed to metalworking fluids and abrasives [Silverstein et al., 1988] and workers exposed to asbestos in a number of industries [Neugut and Wylie, 1987] have been reported to have excesses of stomach and other gastrointestinal cancers. Asbestos has also been used in the jewelry industry. Although no excess of lung cancer or mesothelioma (no cases) was

found in the current study, recently a case of mesothelioma was reported in a worker involved in the fabrication of asbestos soldering forms in the jewelry industry [Kern et al., 1992].

In this study, some excess was noted for malignancies of the hematolymphopoietic system, with elevated PCMRs for leukemia among union males and of non-Hodgkin's lymphoma among jewelry workers in the 24 states, and particularly in Rhode Island. Organic solvents, including trichloroethylene [McCunney, 1988], have been widely used in jewelry manufacture. Associations of organic solvents with these malignancies have been suggested in a number of other industries [Blair et al., 1989, 1990, 1992; Spirtas et al., 1991]. Myelodysplastic disorders [Vineis et al., 1990] and specific translocations at chromosome 14q32 in lymphoma cases [Brandt et al., 1989] have been associated with solvent exposure. Occupational exposure to trichloroethylene is associated with structural chromosomal aberrations and hyperdiploid cells [Rasmussen et al., 1988]. Neither Sparks and Wegman [1980] nor Dubrow and Gute [1987] reported excesses for these malignancies in jewelry workers.

Excesses of cancer of the digestive and hematolymphopoietic systems were identified in this study of jewelers. The lack of site specificity for excessive malignancies raises questions about the etiologic significance of these findings, although the wide variety of exposures in this industry, particularly to metals and solvents, could involve excess risk for malignancy at multiple sites. We do not have detailed information about the specific exposures involved, but jewelry manufacturing in New York has often involved diamond cutting and related occupations, while the Rhode Island industry has largely been associated with the production of costume jewelry [Martin, 1978]. While this study suggests excesses of gastrointestinal cancer, and possibly excesses of hematolymphopoietic malignancies associated with employment in the jewelry industry, further studies to identify the specific risks in this industry would need to consider specific job histories and related occupational exposures.

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